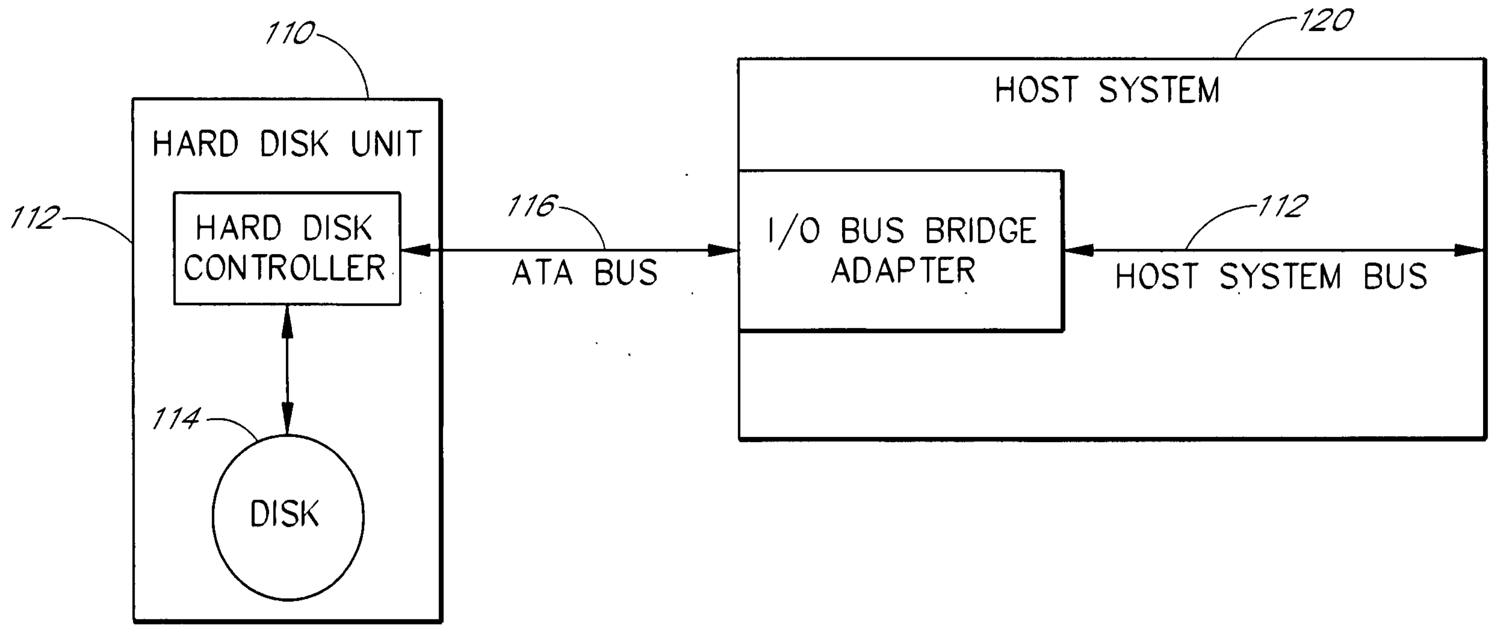

110
112
HARD DISK UNIT
HARD DISK CONTROLLER
114
DISK
116
ATA BUS
120
HOST SYSTEM
I/O BUS BRIDGE ADAPTER
112
HOST SYSTEM BUS

FIG. 1

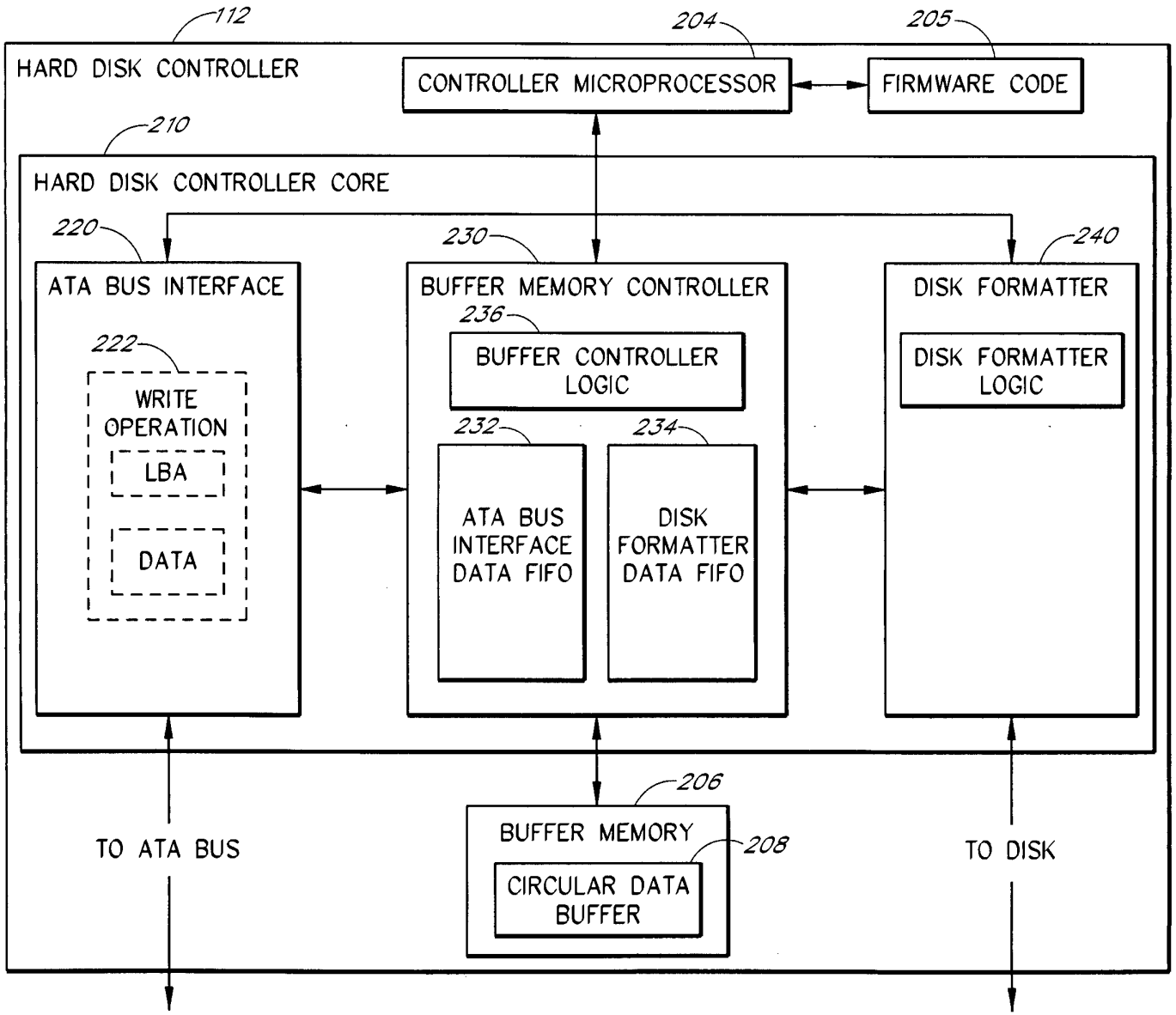
112
HARD DISK CONTROLLER
204
CONTROLLER MICROPROCESSOR
205
FIRMWARE CODE
210
HARD DISK CONTROLLER CORE
220
ATA BUS INTERFACE
222
WRITE OPERATION
LBA
DATA
230
BUFFER MEMORY CONTROLLER
236
BUFFER CONTROLLER LOGIC
232
ATA BUS INTERFACE DATA FIFO
234
DISK FORMATTER DATA FIFO
240
DISK FORMATTER
DISK FORMATTER LOGIC
206
BUFFER MEMORY
208
CIRCULAR DATA BUFFER
TO ATA BUS
TO DISK

FIG. 2

FLOW OF WRITE OPERATION DATA

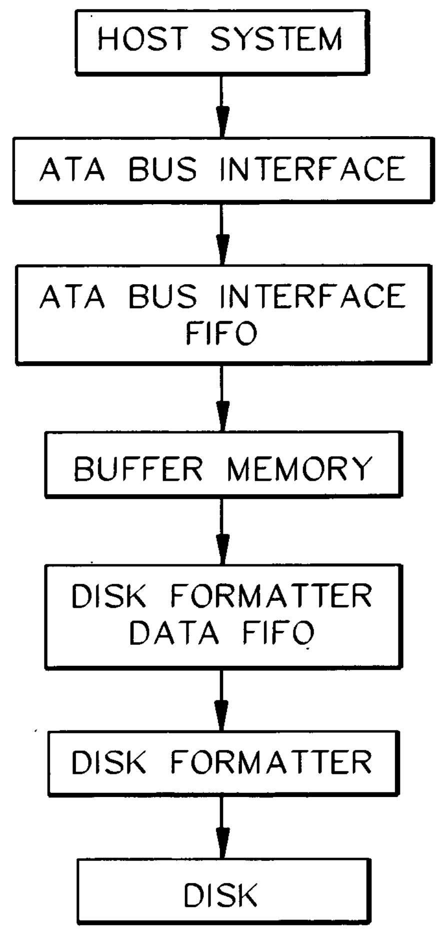

FIG. 3

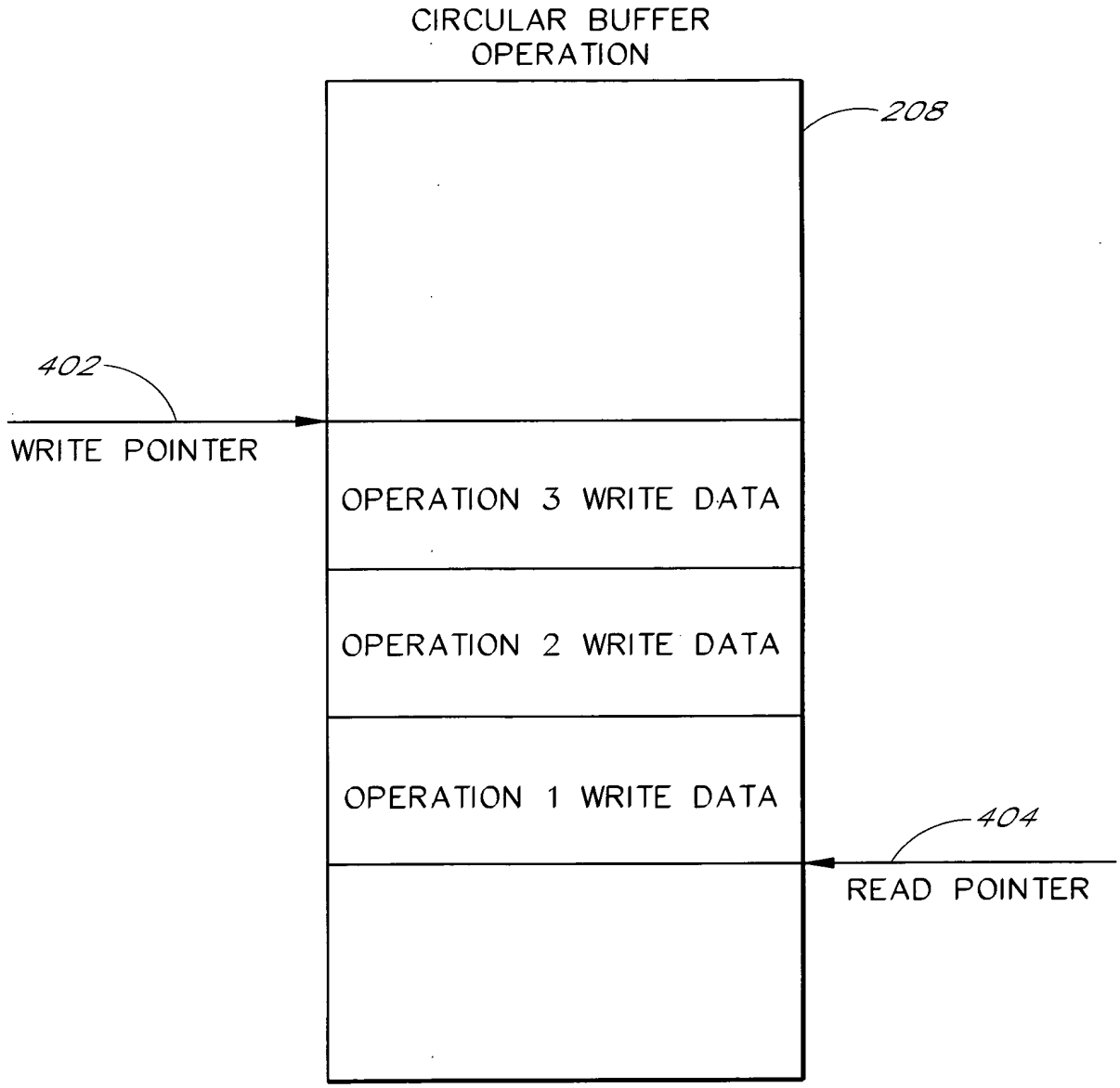
CIRCULAR BUFFER
OPERATION
208
402
WRITE POINTER
OPERATION 3 WRITE DATA
OPERATION 2 WRITE DATA
OPERATION 1 WRITE DATA
404
READ POINTER

FIG. 4

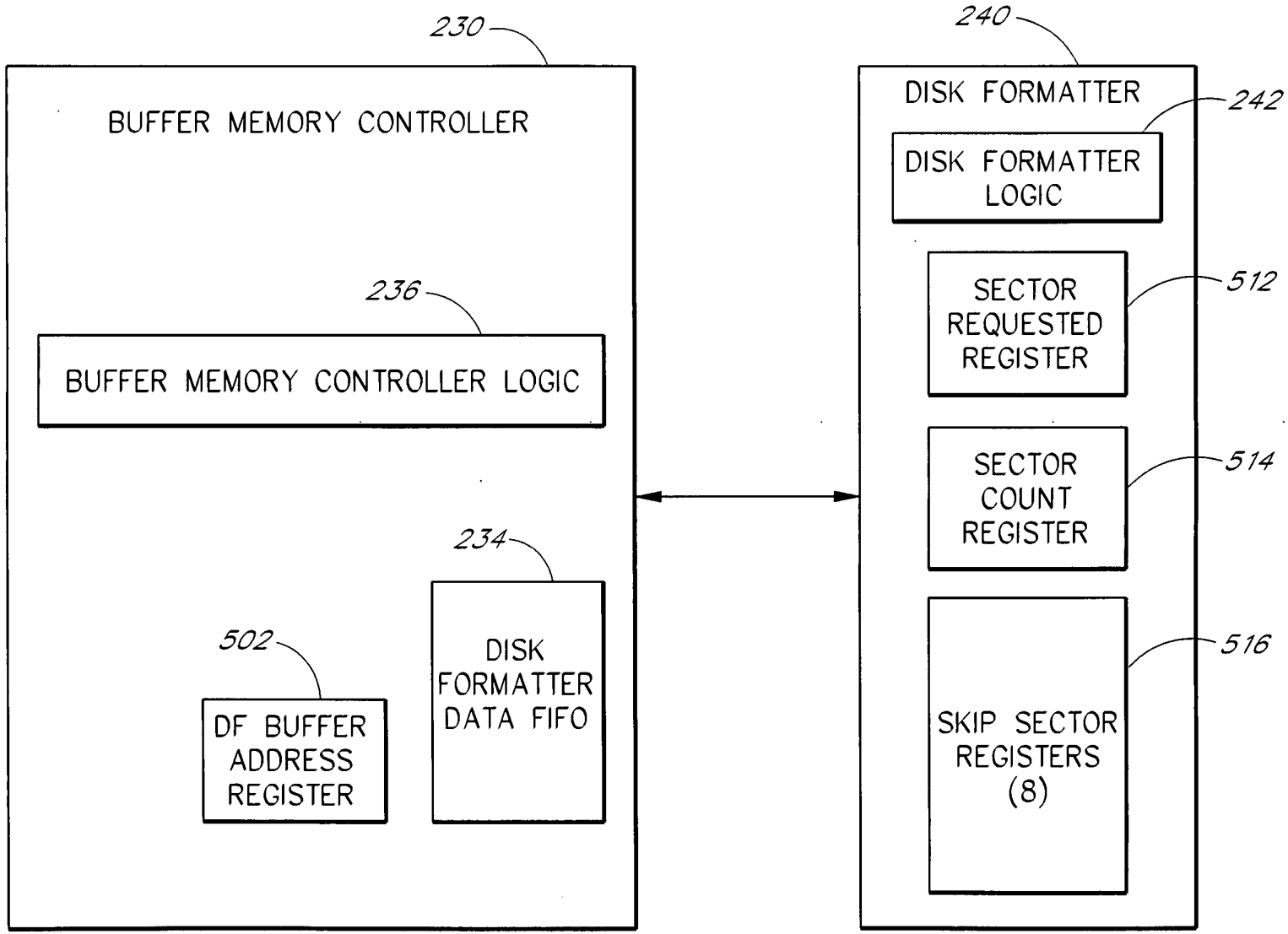

FIG. 5

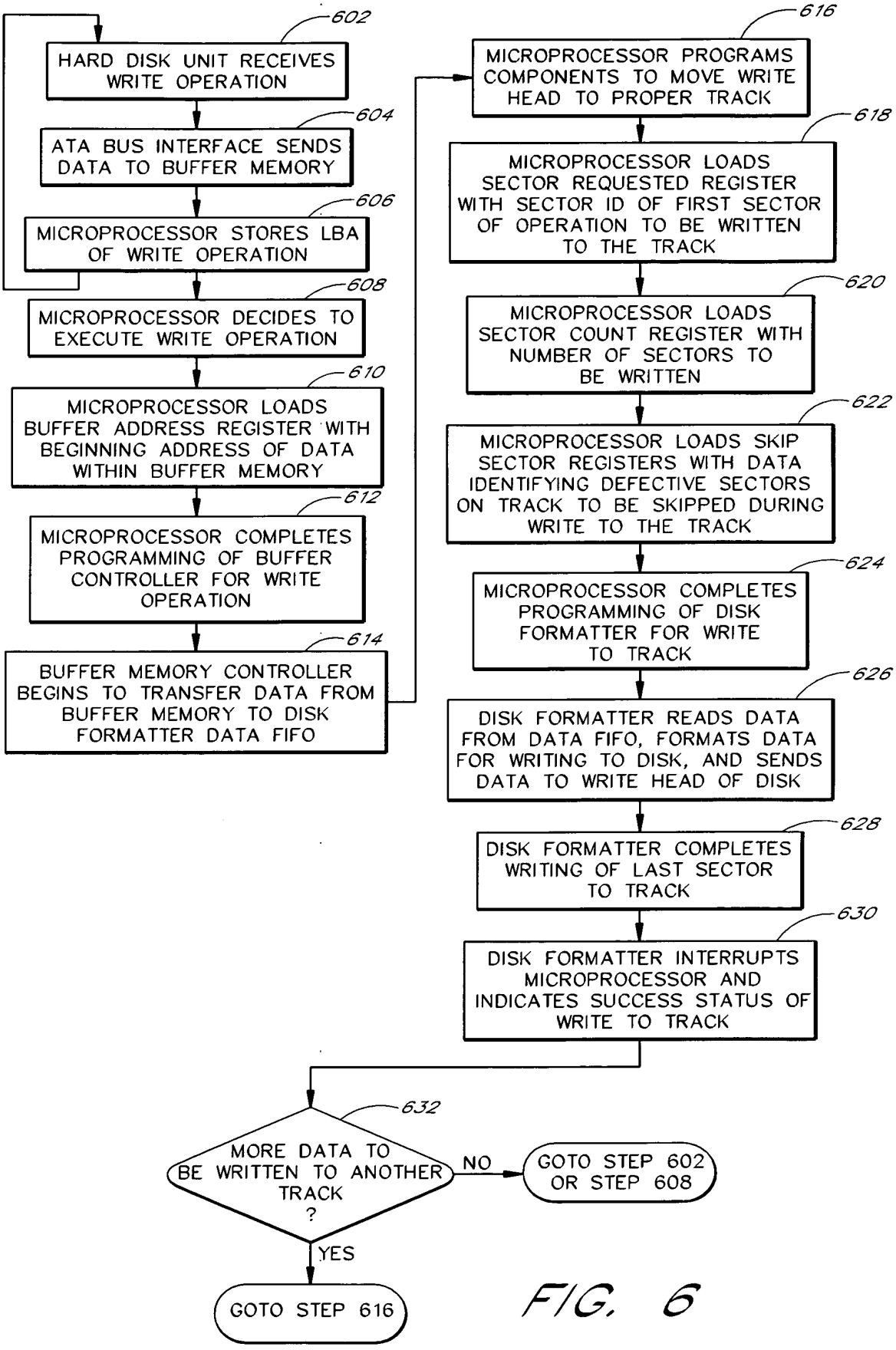
602
HARD DISK UNIT RECEIVES WRITE OPERATION
604
ATA BUS INTERFACE SENDS DATA TO BUFFER MEMORY
606
MICROPROCESSOR STORES LBA OF WRITE OPERATION
608
MICROPROCESSOR DECIDES TO EXECUTE WRITE OPERATION
610
MICROPROCESSOR LOADS BUFFER ADDRESS REGISTER WITH BEGINNING ADDRESS OF DATA WITHIN BUFFER MEMORY
612
MICROPROCESSOR COMPLETES PROGRAMMING OF BUFFER CONTROLLER FOR WRITE OPERATION
614
BUFFER MEMORY CONTROLLER BEGINS TO TRANSFER DATA FROM BUFFER MEMORY TO DISK FORMATTER DATA FIFO
616
MICROPROCESSOR PROGRAMS COMPONENTS TO MOVE WRITE HEAD TO PROPER TRACK
618
MICROPROCESSOR LOADS SECTOR REQUESTED REGISTER WITH SECTOR ID OF FIRST SECTOR OF OPERATION TO BE WRITTEN TO THE TRACK
620
MICROPROCESSOR LOADS SECTOR COUNT REGISTER WITH NUMBER OF SECTORS TO BE WRITTEN
622
MICROPROCESSOR LOADS SKIP SECTOR REGISTERS WITH DATA IDENTIFYING DEFECTIVE SECTORS ON TRACK TO BE SKIPPED DURING WRITE TO THE TRACK
624
MICROPROCESSOR COMPLETES PROGRAMMING OF DISK FORMATTER FOR WRITE TO TRACK
626
DISK FORMATTER READS DATA FROM DATA FIFO, FORMATS DATA FOR WRITING TO DISK, AND SENDS DATA TO WRITE HEAD OF DISK
628
DISK FORMATTER COMPLETES WRITING OF LAST SECTOR TO TRACK
630
DISK FORMATTER INTERRUPTS MICROPROCESSOR AND INDICATES SUCCESS STATUS OF WRITE TO TRACK
632
MORE DATA TO BE WRITTEN TO ANOTHER TRACK ?
NO
GOTO STEP 602 OR STEP 608
YES
GOTO STEP 616

FIG. 6

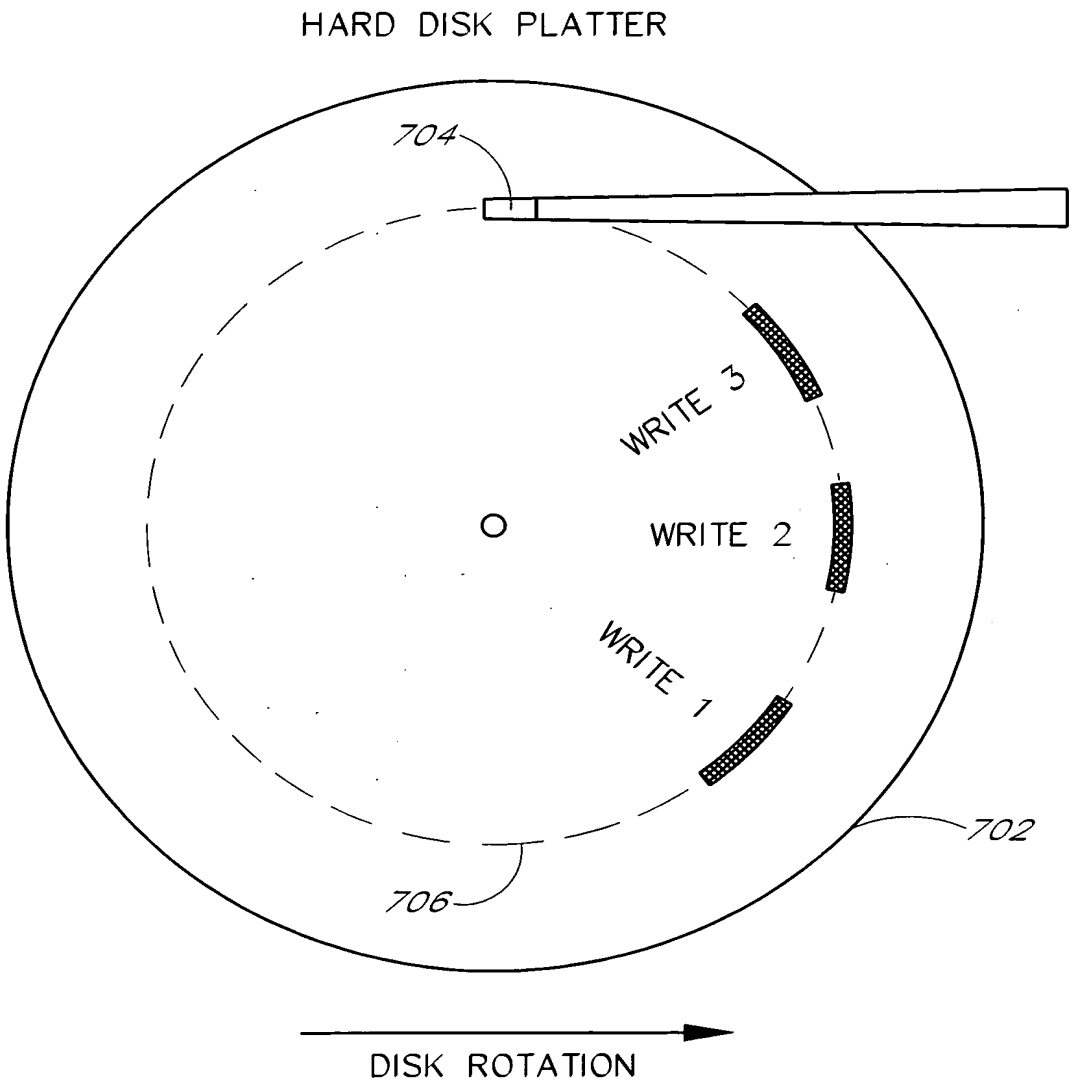

FIG. 7

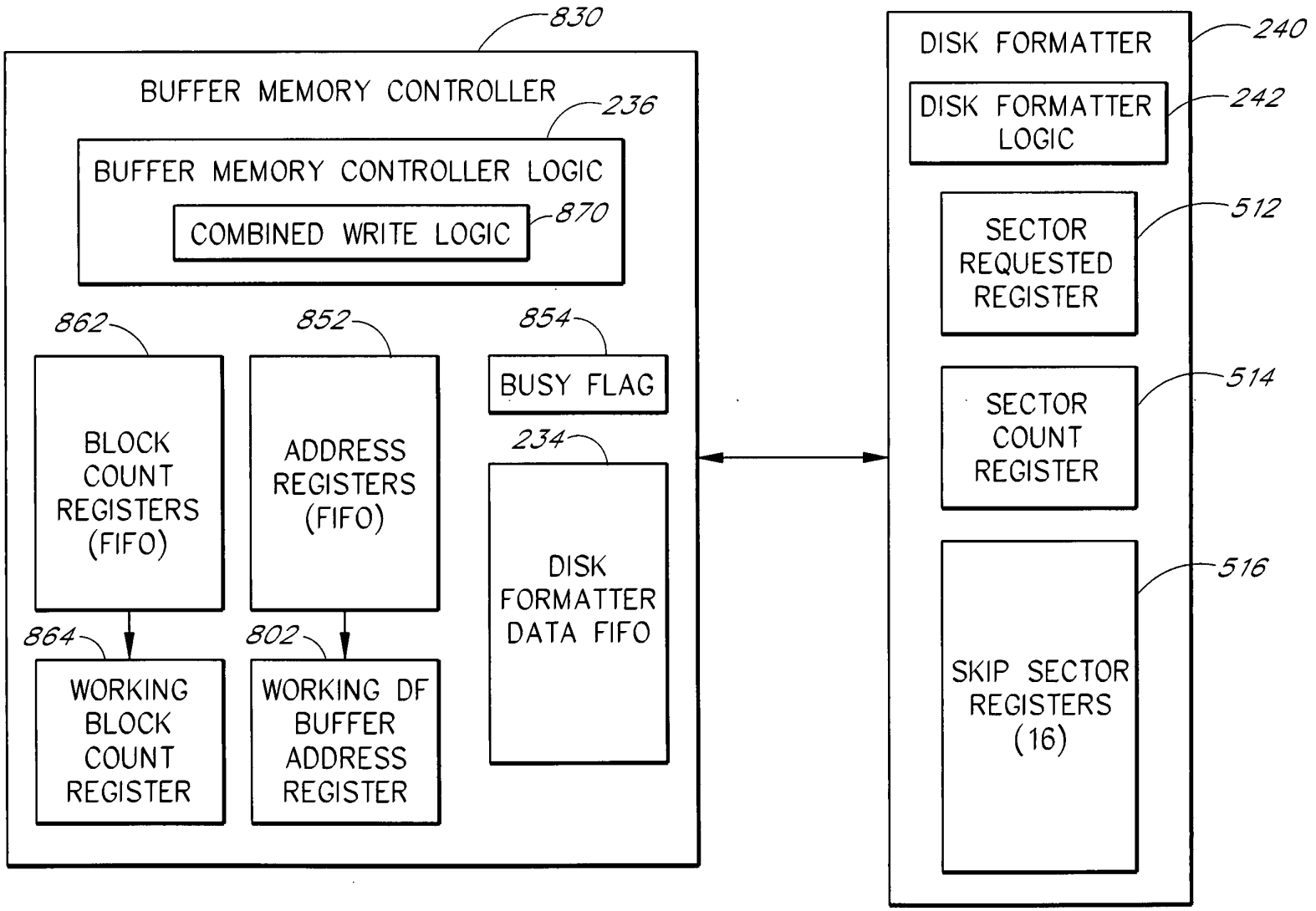

FIG. 8

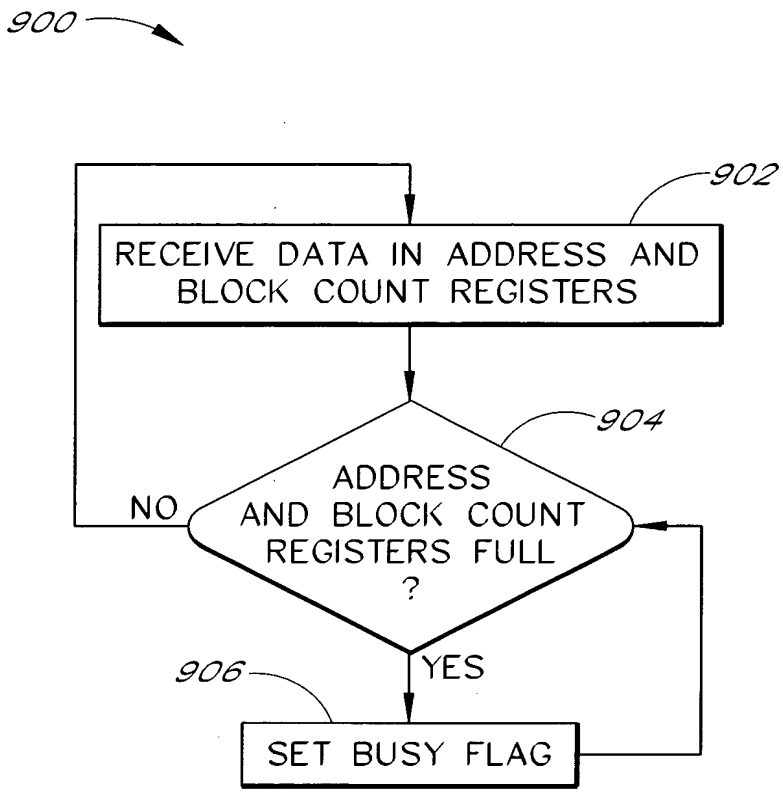

FIG. 9A

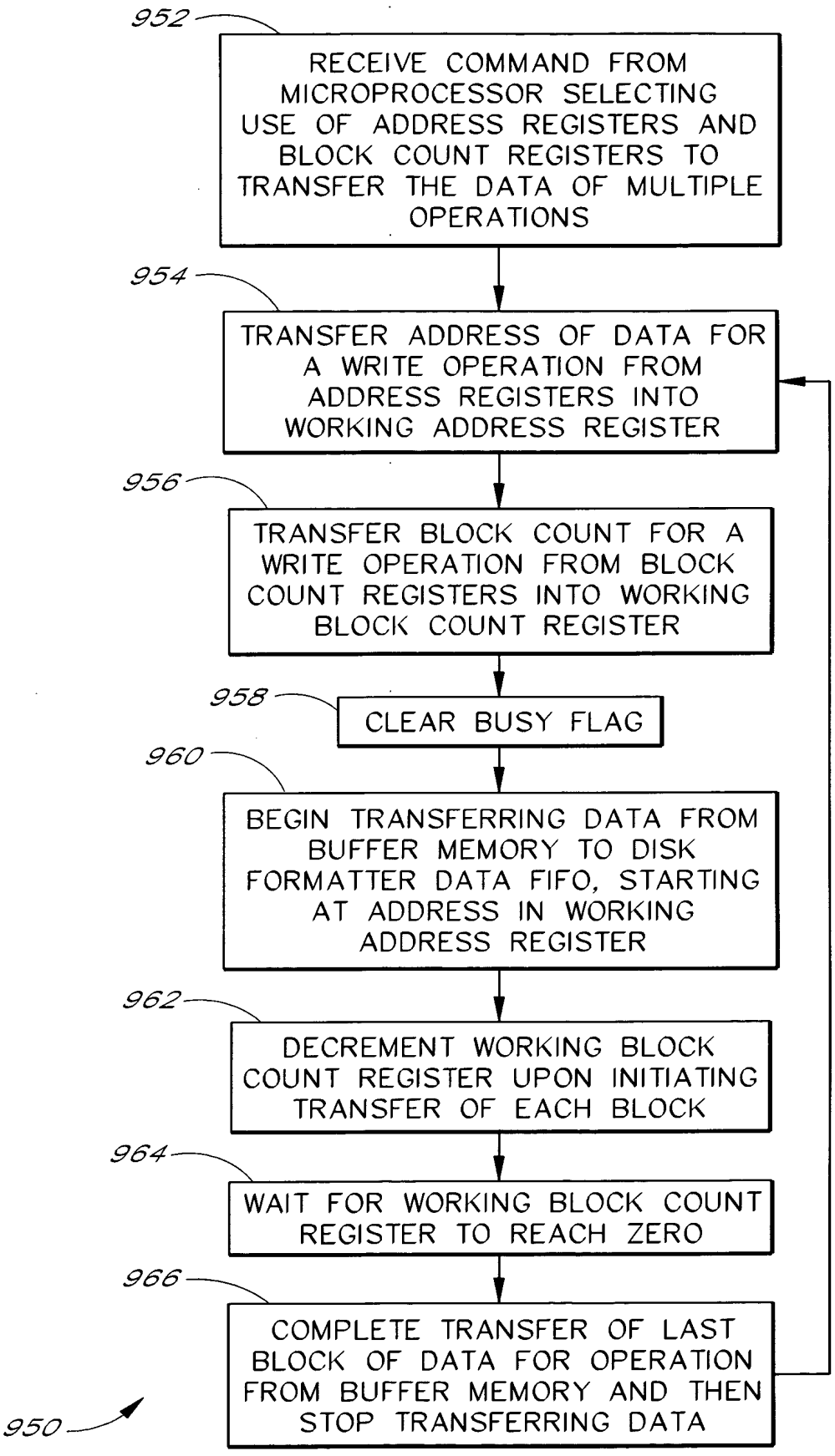
952
RECEIVE COMMAND FROM MICROPROCESSOR SELECTING USE OF ADDRESS REGISTERS AND BLOCK COUNT REGISTERS TO TRANSFER THE DATA OF MULTIPLE OPERATIONS
954
TRANSFER ADDRESS OF DATA FOR A WRITE OPERATION FROM ADDRESS REGISTERS INTO WORKING ADDRESS REGISTER
956
TRANSFER BLOCK COUNT FOR A WRITE OPERATION FROM BLOCK COUNT REGISTERS INTO WORKING BLOCK COUNT REGISTER
958
CLEAR BUSY FLAG
960
BEGIN TRANSFERRING DATA FROM BUFFER MEMORY TO DISK FORMATTER DATA FIFO, STARTING AT ADDRESS IN WORKING ADDRESS REGISTER
962
DECREMENT WORKING BLOCK COUNT REGISTER UPON INITIATING TRANSFER OF EACH BLOCK
964
WAIT FOR WORKING BLOCK COUNT REGISTER TO REACH ZERO
966
COMPLETE TRANSFER OF LAST BLOCK OF DATA FOR OPERATION FROM BUFFER MEMORY AND THEN STOP TRANSFERRING DATA
950

FIG. 9B

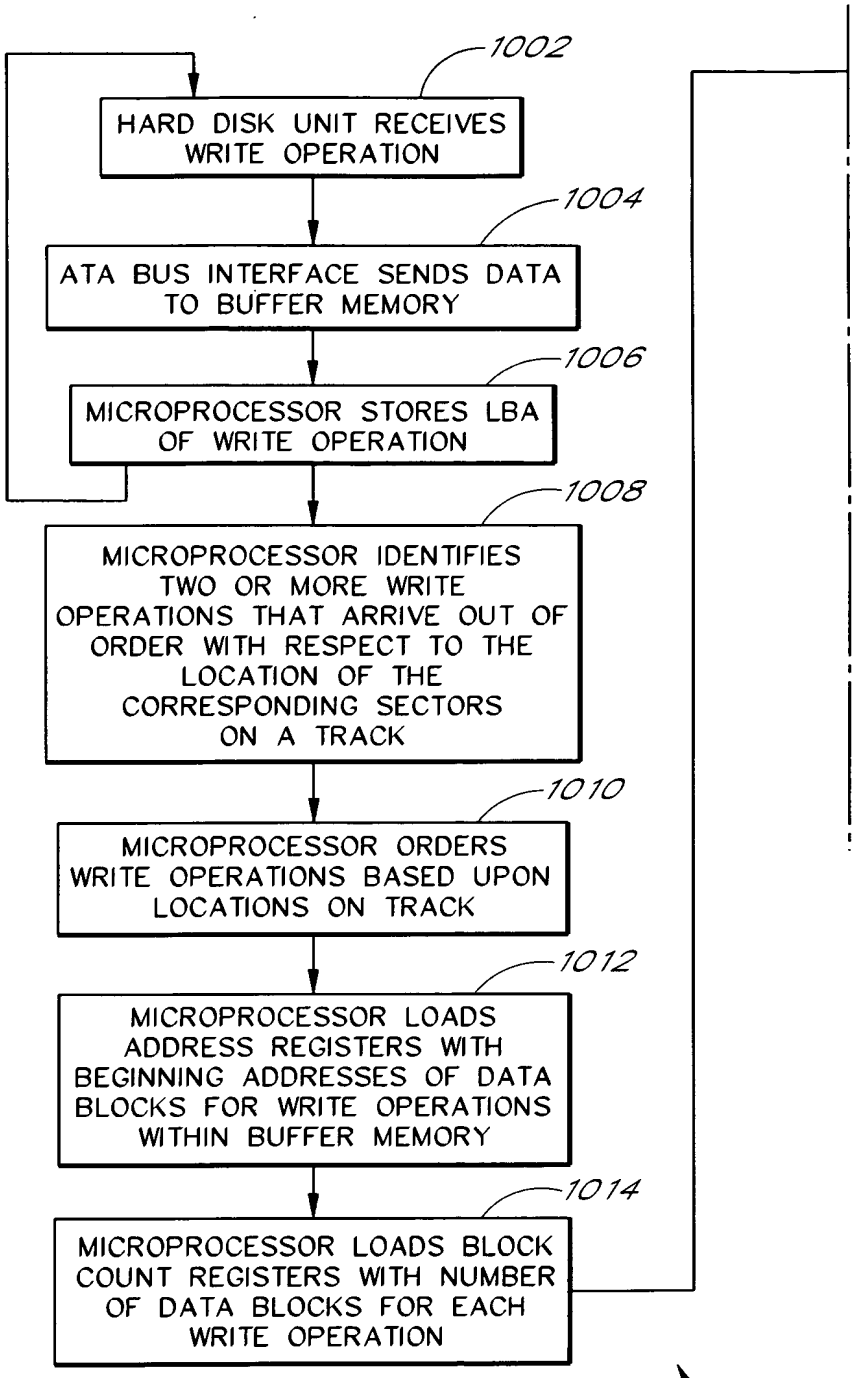

FIG. 10A

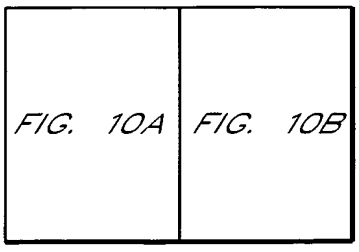

FIG. 10

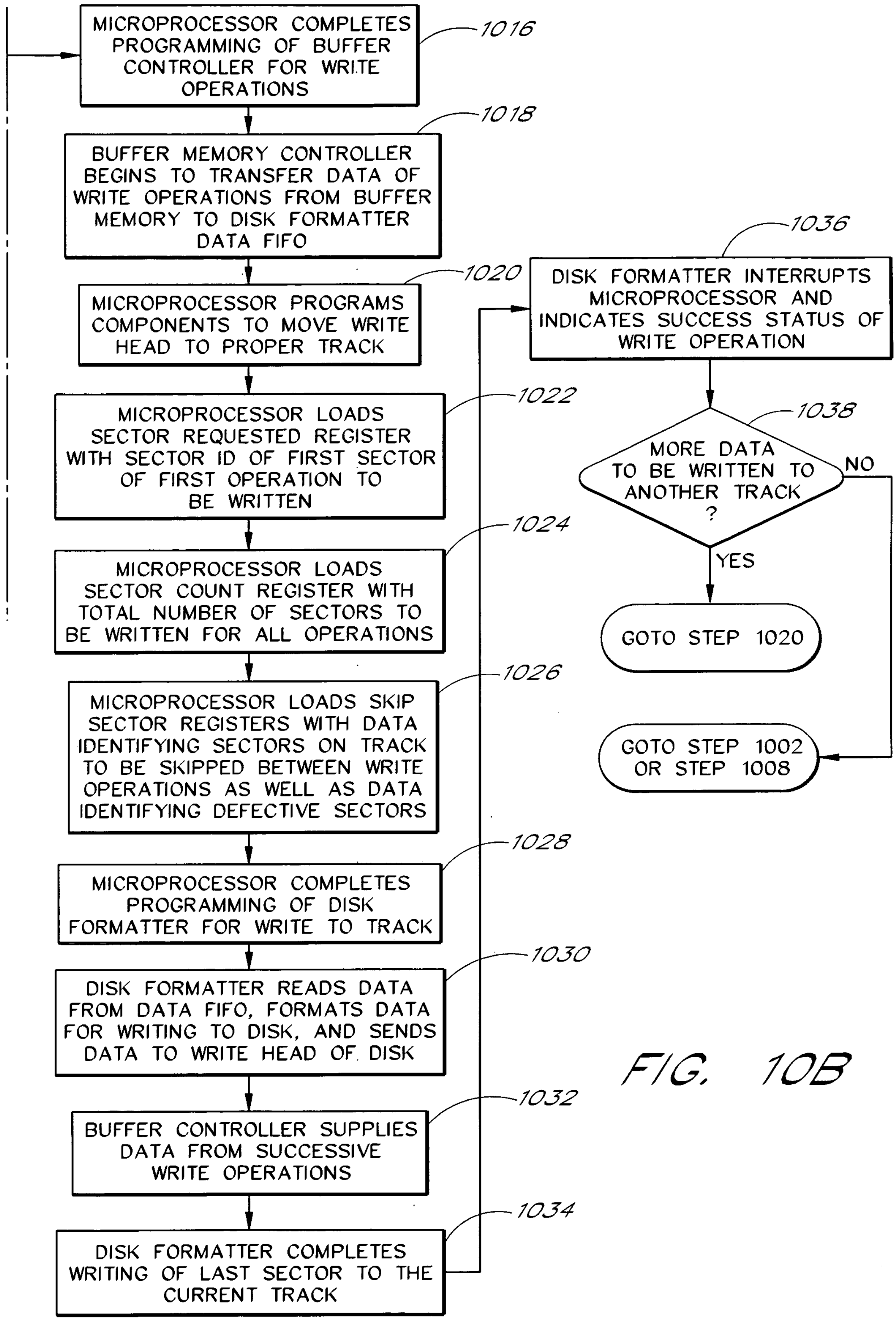
MICROPROCESSOR COMPLETES PROGRAMMING OF BUFFER CONTROLLER FOR WRITE OPERATIONS
1016
BUFFER MEMORY CONTROLLER BEGINS TO TRANSFER DATA OF WRITE OPERATIONS FROM BUFFER MEMORY TO DISK FORMATTER DATA FIFO
1018
MICROPROCESSOR PROGRAMS COMPONENTS TO MOVE WRITE HEAD TO PROPER TRACK
1020
MICROPROCESSOR LOADS SECTOR REQUESTED REGISTER WITH SECTOR ID OF FIRST SECTOR OF FIRST OPERATION TO BE WRITTEN
1022
MICROPROCESSOR LOADS SECTOR COUNT REGISTER WITH TOTAL NUMBER OF SECTORS TO BE WRITTEN FOR ALL OPERATIONS
1024
MICROPROCESSOR LOADS SKIP SECTOR REGISTERS WITH DATA IDENTIFYING SECTORS ON TRACK TO BE SKIPPED BETWEEN WRITE OPERATIONS AS WELL AS DATA IDENTIFYING DEFECTIVE SECTORS
1026
MICROPROCESSOR COMPLETES PROGRAMMING OF DISK FORMATTER FOR WRITE TO TRACK
1028
DISK FORMATTER READS DATA FROM DATA FIFO, FORMATS DATA FOR WRITING TO DISK, AND SENDS DATA TO WRITE HEAD OF DISK
1030
BUFFER CONTROLLER SUPPLIES DATA FROM SUCCESSIVE WRITE OPERATIONS
1032
DISK FORMATTER COMPLETES WRITING OF LAST SECTOR TO THE CURRENT TRACK
1034
DISK FORMATTER INTERRUPTS MICROPROCESSOR AND INDICATES SUCCESS STATUS OF WRITE OPERATION
1036
MORE DATA TO BE WRITTEN TO ANOTHER TRACK ?
1038
NO
YES
GOTO STEP 1020
GOTO STEP 1002 OR STEP 1008

FIG. 10B

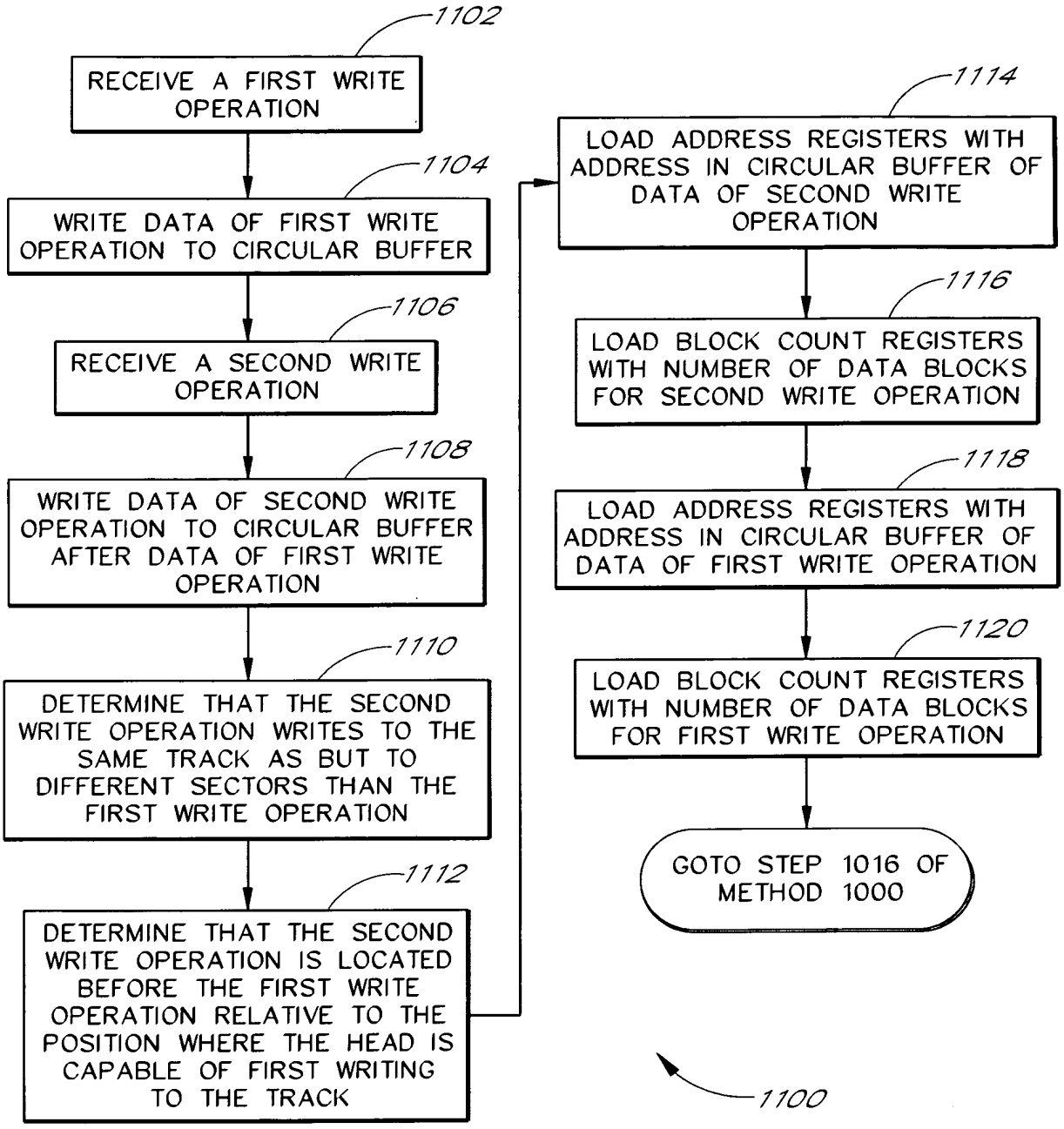
1102
RECEIVE A FIRST WRITE OPERATION
1104
WRITE DATA OF FIRST WRITE OPERATION TO CIRCULAR BUFFER
1106
RECEIVE A SECOND WRITE OPERATION
1108
WRITE DATA OF SECOND WRITE OPERATION TO CIRCULAR BUFFER AFTER DATA OF FIRST WRITE OPERATION
1110
DETERMINE THAT THE SECOND WRITE OPERATION WRITES TO THE SAME TRACK AS BUT TO DIFFERENT SECTORS THAN THE FIRST WRITE OPERATION
1112
DETERMINE THAT THE SECOND WRITE OPERATION IS LOCATED BEFORE THE FIRST WRITE OPERATION RELATIVE TO THE POSITION WHERE THE HEAD IS CAPABLE OF FIRST WRITING TO THE TRACK
1114
LOAD ADDRESS REGISTERS WITH ADDRESS IN CIRCULAR BUFFER OF DATA OF SECOND WRITE OPERATION
1116
LOAD BLOCK COUNT REGISTERS WITH NUMBER OF DATA BLOCKS FOR SECOND WRITE OPERATION
1118
LOAD ADDRESS REGISTERS WITH ADDRESS IN CIRCULAR BUFFER OF DATA OF FIRST WRITE OPERATION
1120
LOAD BLOCK COUNT REGISTERS WITH NUMBER OF DATA BLOCKS FOR FIRST WRITE OPERATION
GOTO STEP 1016 OF METHOD 1000
1100

FIG. 11